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Twisted Dipoles

Recently, arc dipole magnets such as DRG516 have demonstrated as much as 8 mrad twist from one end to the other. How big can this angle, ϕ, be?

An arc dipole has a length $L \approx 10$ m, a bend angle $\theta \approx 38$ mrad. Suppose that half of it is twisted by $-\phi/2$, and the other half by $+\phi/2$. Then this magnet induces a vertical dispersion step given by

$$|\Delta\eta_{\rm VERT}| \simeq \theta\frac{L}{2}\frac{\phi}{2} \approx 0.1\phi \ \ [\rm m]$$

Replacing ϕ by its rms value σ_ϕ, adding randomly for $N \approx 165$ dipoles, and ignoring a factor of 2

$$< \eta_V^2 >^{\frac{1}{2}} \simeq \sqrt{N}0.1\ \sigma_\phi \simeq 1.3\ \sigma_\phi \ \ [\rm m]$$

Adopting a conservative criterion that

$$< \eta_V^2 >^{\frac{1}{2}} \leq 0.01 \ \ [\rm m]$$

gives

$$\sigma_\phi \leq 10 \text{ mrad}$$

1. This is fairly easy to achieve
2. This assumes that the average roll is accurately removed
3. The words "vertical dispersion" and the symbol "η_V" can be everywhere replaced by "vertical closed orbit" and "y_{co}".